1-1-1988

The Role of Maternal Schooling and Its Interaction with Public Health Programs in Child Health Production

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CENTER DISCUSSION PAPER NO. 551

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January 1988

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I would like to thank T. Paul Schultz and John Strauss for guiding this research, Robert Evenson, Jere Behrman and the anonymous referees for helpful comments and suggestions, and Charlie Griffin for help in initially setting up the data. Any errors which remain are solely mine. This paper is part of a dissertation at Yale.

Abstract

Three questions are addressed in this paper: (1) Does mother's schooling affect child health? (2) If so, does its impact vary across child age groups? (3) How and why does maternal schooling affect child health? Maternal education positively affects child health as measured by height-for-groups, with preschoolers showing the greatest sensitivity. The pattern of interations between maternal education and public health programs suggests that maternal education affects child health through an efficiency effect (by affecting the productivity of health inputs) and an allocative effect (by lowering the costs of information).

1. INTRODUCTION

Health is a commodity for which there is no market and must be produced within the household. Conditions within the household are therefore expected to be important determinants of child health. The mother plays the central role in household domestic activities especially those which pertain to child rearing. As a result, the mother has been commonly described as the most important health worker. How well a mother performs this task may depend on her schooling which equips her with general and specific knowledge, and the means and confidence to seek new ideas. These enhance her ability to control her immediate environment. One might therefore expect maternal education to contribute positively to child health.

2. ISSUES

2.1 AGE-DIFFERENTIATED IMPACT

Is this expectation supported by empirical evidence? The medical, public health, and nutrition literature generally show a positive association between mother's schooling and child health. However, the methodology of most of these studies is inadequate because conclusions are drawn from simple cross tabulations. They do not control for other important factors which may be highly correlated with

maternal education, such as income or place of residence, thereby imputing too much to maternal education. On the other hand, studies which do use multivariate regression, including those done by economists, often are also unsatisfactory. Their estimates are statistically biased and inconsistent because of simultaneity problems arising from the inclusion of household choice variables[1] among the regressors in the analysis (Wolfe & Behrman,1982; Ryan, et.al.,1984; Martorell,et.al.,1984; Battad,1978; Heller & Drake,1979; Smith,et.al.,1983). In addition, some results are difficult to interpret as it is unclear whether reduced-form or structural equations are being estimated (Ryan,et.al., 1984; Battad,1978; Martorell,1984).

To examine the role and importance of maternal schooling in child health, one can look at how maternal education's impact varies across different child age groups. Younger children are relatively more dependent on the mother for their needs compared to older children. Furthermore, there are age-specific differences in health production among children. The medical and public health literature show that young preschoolers have different biological make-ups and undergo a critical transition period. They have underdeveloped immune systems and are relatively more

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[1] Examples of these endogenous variables are mother's labor market participation, family size, food intake, number of siblings, morbidity, birth interval, breastfeeding and weaning behavior, and use of birth control.

vulnerable to infections and disease. They are in a stage of fast growth which coincides with a period of changing diet from breastmilk to prepared foods. Breastfeeding alone becomes inadequate for their nutrient requirements. This causes trauma and stress for the young child (Gordon,1963)[2]. The diet deteriorates in quality and perhaps quantity. It is not surprising, therefore, that child health outcomes have generally exhibited a decline from 6 months of age through the second year of life, followed by a turnaround and a continuous improvement thereafter. This observed U-shaped pattern of deterioration-subsequent improvement in health among preschoolers is true whether health outcome is measured in terms of nutritional status[3] or morbidity.[4] The risk of death for a given nutritional status decreases with child's age (Kielmann & McCord, 1978) as she moves beyond this critical transition period.

These factors plus the preschooler's complete dependence on the mother make very young children particularly sensitive to the proper choice and efficient use of health

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[2] Change is always traumatic and stressfull. Gordon (1963) cites other mammals such as baby pigs, calves, kittens, and mice which experience the same syndrome as human babies during this period.

[3] Anderson, 1979; Gordon, et.al., 1967; Levinson, 1974; Martorell, et.al., 1975; Mata, et.al., 1975;Pigott & Kolasa, 1979; Rao, 1980;Valverde, et.al., 1980; Wray, 1978.

[4] Briscoe, 1978; Gopaldas, et.al., 1983; Gordon, et.al., 1967;Kawata, 1978; Martorell, 1982; Mata, et.al., 1975; Rao, 1980.

inputs. The research implication of this is that maternal education may be relatively more important for the younger age groups. One can therefore pose the following hypothesis: Maternal education is an important determinant of child health. Its importance varies across age groups, being greatest among children in the weaning period (0-2 years old).

This hypothesis can be tested by estimating the health reduced-form equation for samples of children stratified by age. No one has used age-specific differences in child health production to evaluate the varying importance of maternal education in the different stages of child development.

2.2 NATURE OF MATERNAL EDUCATION'S ROLE

Why and how does mother's education affect child health? Mother's education affects child health through the following channels:

1. it increases the economic resources available to the family through assortative mating with wealthier men, through her own increased earnings from market efficiency gains (Schultz,1984; Ware, 1984), and through an increase in full incomes brought about by non-market efficiency gains (Michael,1973).

2. it augments the productivity of health inputs through an increase in the mother's non-market efficiency (Michael,1973; Welch,1970;Rosenzweig & Schultz,1985).
3. it improves the allocation of resources as a result of better knowledge and access to information (Welch,1970).
4. it affects household preferences given prices, income, efficiency and information (Caldwell,1979).

Identifying which are the predominant channels through which maternal education affects child health is a valuable exercise for the purposes of policy formulation. By knowing why and how maternal education affects child health, it may be possible to duplicate these channels in less costly and less roundabout programs other than a general education campaign. Besides, it is important to sort out which are the predominant operative channels because of their varying distributional implications for public health programs.

By observing the pattern of interactions between maternal education and public health programs, it is possible to infer the most likely channels through which maternal schooling affects child health. Rosenzweig & Schultz (1982) and Schultz (1984) propose a matrix which shows the possible interactions depending on the type of public health programs and the role played by maternal education. Their matrix is reproduced in Table 1. Public health programs can be divided into three functional categories. They can (1)

provide health information, as in nutrition education programs, family planning awareness campaigns, etc., (2) subsidize health inputs, as in supplementary feeding programs, MCH clinics, nutrition rehabilitation centers, etc., or (3) improve the healthiness of the environment, as in mosquito fumigation, swamp drainage, and schistosomiasis control programs.[5] These various functions define the column headings of the matrix. The various channels through which maternal education can affect child health define the rows.

The interaction between the type of public health program and the role of maternal education determines which mothers, and consequently which children, benefit more from the health program. These are shown as the elements of the matrix. Maternal education serves either as a substitute for or complement to community health programs. It serves as a substitute by providing information on health and personal hygiene. It serves as a complement when it facilitates the use of available health programs via an increase in income and/or knowledge on the value of these services. The type and nature of public health programs are generally known and thus allows one to identify which column of Table 1 is relevant. The pattern of substitution (-) and complementarity (+), can be estimated by interacting maternal education with local access public health programs

[5]It is possible of course to have programs combine two or more of these functions together.

in the reduced-form equation for child health. One may thus infer which of the rows (maternal education's roles) is operative.

This paper (1) tests the hypothesis of a differential impact of maternal schooling[6] on health performance across various child age groups, (2) examines the pattern of interaction of maternal education with various public health programs, and (3) identifies the predominant channels through which maternal education affects child health. The next section is a presentation of the model. Section 4 is a description of the data and the empirical specification. Section 5 presents the estimation results and conclusions.

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[6] Maternal schooling may also be indicative of the better socioeconomic status and willingness of the parents (of the mother) to make human capital investments such as better nutrition and better training in homemaking which affect her (the mother) current ability at raising children. If so, the contribution of maternal education to child health will be overestimated. Behrman & Wolfe (1987) recognize this problem and use a Linear Structural Relations (LISREL) model. Their empirical results show that maternal schooling loses its significance in the child health production function with the inclusion of a latent variable for maternal endowments. Unfortunately, the technique they employ to control for unobserved maternal endowments cannot be used in this sample because of the absence of data on the mother's childhood environment. This, however, does not alter the basic findings of the paper. One simply has to give a broader interpretation to mother's education in the subsequent discussion, as serving as a proxy for her human capital, including health-related skills and habits picked up from her childhood family environment and training.

3. MODEL

The household maximizes utility by its choice of consumption of child health (H) and other commodities (Z).

$$U = U(H,Z) \qquad (1)$$

Child health is an output of the production function

$$H=h(X^*,I) \qquad (2)$$

where X* is the effective units of a "mother-intensive" input and is a function of the mother's education and input X.

$$X^* = kX \text{ , where } k=k(E)$$

E=mother's education

An increase in maternal schooling augments the effective units of the "mother-intensive" input X* through its efficiency and allocative effects.

$$k'(E) > 0$$

The budget constraint is

$$Y \geq P_X X + P_I I + P_Z Z$$

where P_i = price of good i

Y = income

The household maximizes its utility subject to the health production function and budget constraint.

The change in health production given a change in mother's education is given by:

$$\frac{dH}{dE} = - H\left(\frac{k'(E)}{k}\right)\left[\alpha_{X^*}\left(h_{X^*,\ \frac{P_X}{k}}\right) + (1 - \alpha_{X^*})\left(h_{I,\ \frac{P_X}{k}}\right)\right] \qquad [3]$$

where $\alpha_{X^*} = \frac{H_{X^*}kX}{H}$ = the production share of X*

$h_{i,\ \frac{Px}{k}}$ = elasticity of i with respect to P_X/k,

where i = X*,I

This equation predicts that if the production share of the "mother-intensive" input (α_{X^*}) in health production varies across age groups,[7] then mother's education will affect child health differently across age groups. The bigger the production share, the greater (lesser) is the irovement (worsening) in child health. Hence, one would expect younger age groups to show the most gains from an increase in maternal schooling as the production share of "mother-intensive" inputs is relatively greater among these children.

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[7] as is likely to be the case because infants are more dependent on the mothers for their needs relative to the older children

4. DATA SETS

The data analyzed here are the Bicol (Philippines) Multipurpose Survey of 1978 and its Supplementary Survey of 1981. The Bicol Multipurpose Survey has community, household, and individual-level information on 1903 households. Community-level information include data on the type and condition of infrastructure, health and government extension services, and environmental sanitation. The household-level data include a rich collection of socioeconomic, production, and demographic information. The individual-level data has anthropometric measurements, morbidity, and time allocation information. The Supplementary Survey of 1981 has detailedormation on health services available to the sampled households. These surveys are described in Popkin, et. al. (1979) and Akin, et.al.(1985).

The sample consists of 3821 children below the age of 15 coming from 1383 households for which core socioeconomic and health information are available.[8] Table 2 presents the variables used and their statistics.[9]

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[8]Children who were absent at the time of the survey (presumably due to work or school) are excluded from this sample. Using the Heckman (1979) correction procedure, no sample self-selection is evident as a result of dropping children with missing height information. The coefficients of lambda were statistically insignificant (ranging from 24% to 95%).

[9]Caution must be exercised in treating community-level characteristics as exogenous as is done in this paper.

Child health is measured by height-for-age (HTAGE) scores. Height-for-age is chosen because it is believed to be a long-run measure of nutritional status and because it is not subject to transitory shocks.[10] These scores are calculated by dividing the child's height by the median height from the NCHS standards (Behrman & Vaughan,1983). The education variable is measured by years of schooling. The water, sanitation and health care variables are taken from the 1981 survey.[11] The household income variable includes all sources of income for the family except the mother's cash and non-cash earnings in order not to pick up the contribution of mother's education in increasing family income.

Mother's height is used as a proxy for her gtic traits and health endowment which has a direct bearing on the child's health through better birthweights. Graham (1972) &

In the presence of a central government which allocates public health infrastructure in a compensatory pattern, and with migration giving rise to a process of self-selection, location characteristics may in fact be endogenous (Shultz, 1988; Rosenzweig & Wolpin, 1986; Rosenzweig & Schultz, 1983). In the absence of time variation and appropriate instruments in this data, it is not possible to treat community-level variables as endogenous.

[10] For example, weight loss may occur as a result of a bout of illness in the period immediately preceding the survey. In such a case, the measured weight will not provide an accurate picture of the child's nutritional status.

[11] An assumption is being made here that the condition of community water, sanitation and health care facilities in 1981 were similar to those prevailing in 1978.

Schultz (1987) show that children of tall parents exhibit better health performance. Mother's height, therefore, is included in the specification.

5. EMPIRICAL RESULTS

5.1 AGE-DIFFERENTED IMPACT OF MATERNAL SCHOOLING

The health reduced-form equation is estimated for the full sample and the results are presented in the first column of Table 3. Maternal education has a positive and statistically significant[12] coefficient. There is no evidence of sex discrimination against females. If anything, they are favored. Mother's height is a significant predictor with a positive sign and is highly significant statistically. Mother's age is a positive and statistically significant determinant. Community cleanliness improves child health as seen from the better performance of children in communities where there is an absence of excreta in the environment. Children in towns perform relatively better than those in villages. Income has the right sign but is not statistically significant.

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[12] For this paper, statistical significance is set at five percent, two-tailed test, except in cases where the sign is implied by theory, in which case a one-tailed test is used.

To test the rest of the hypothesis, the health reduced-form equation is reestimated by age groups and presented in the rest of Table 3. Maternal education does have a differential impact across age groups as predicted by equation 3 All the groups show a positive sign and statistical significance for the coefficient of mother's education. It is only for the oldest children that the statistical significance is marginal (11%). The t-statistics increase in value as we move toward younger age groups. This pattern is also observed in the size of the coefficients thereby confirming thehypothesized differential impact. The 0-2 year olds have a coefficient 2.4 times greater than that of the 11-15 year olds.[13]

Sex is not an important determinant with the exception of the oldest group where females have better height-for-age scores than males. The community sanitation variables do not form any patterns and give mixed results. The availability of sanitary waste disposal facilities in the community leads to better health for the oldest children but not for the rest. In fact, it has the wrong sign for preschoolers. An

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[13]To examine the importance of taking maternal endowments into account (partly proxied in this case by mother's height), the regressions were run without mother's height. The explanatory power of the equations is reduced as seen in lower r-squares and F-statistics. Furthermore, the coefficients of maternal education drastically increase with gains ranging from 26% for the youngest age group to 81% for the oldest group. This gives one an idea of the overestimation of maternal education's contribution to child health if maternal endowment is not controlled for.

environment free from excreta leads to better health for the 11-15 and 3-6 year olds but not for the others. The seeming immunity of the 0-2 year age group to the state of community cleanliness can be explained by their limited mobility and dependence on mothers for their needs. This enables mothers to protect se children against an unclean environment. The next section provides empirical support for this claim.

The availability of a safe source of water is a positive and statistically significant determinant of health for the 0-2 year olds. The coefficients for the travel time to the least-cost child outpatient facility do not exhibit the expected negative sign (except for the 7-10 year olds) and are not statistically significant (except for the 0-2 year olds). Perhaps quality and cost vary such as to lead parents to respond to a more complicated measure of distance to the least cost facility for a specified quality.

Coefficients for the various prices do not show any statistical significance. Income shows the expected sign (except for 3-6 year olds) but is not statistically significant. This finding is consistent with those of Behrman and Wolfe (1984) and Wolfe & Behrman (1983) for a Nicaraguan sample. They find income to be overrated in the literature as an important determinant of nutrition.

The regression as a whole is statistically significant as evidenced by the high F-statistics. One persistent and

strong pattern across all age groups is the positive impact of mother's height and age. These coefficients have the highest statistical significance across all equations. Mother's age may proxy her accumulated experience both in the labor market and in household domestic activities including child rearing. This should lead to a positive effect on child health. Furthermore, childbearing at a very young age is believed to cause health problems for both the mother and child. A higher age the mother may be indicative of her decision to postpone marriage and/or childbearing until such time that she feels ready for homemaking and adequately prepared to raise "quality" children.[14]

These results[15] confirm the hypothesis posed: Maternal education affects child health outcomes. Its impact varies across age groups, being relatively more important for the younger children. These are the children who gain the most from an improvement in maternal schooling.

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[14] Hence, inclusion of mother's age as a regressor may give rise to a possible simultaneity bias because of the endogeneity of mother's age at first child birth.

[15] Horton (1986) analyzes the issue of quantity-quality tradeoff using this data set. Her results show that mother's education is not a statistically significant determinant of child height-for-age. This discrepancy in results may be due to the difference in the samples used (3821 in this study vs. 2672 in Horton's) and/or the inclusion of endogenous variables such as mother's occupation and number of siblings in Horton's study.

5.2 INTERACTION OF MATERNAL SCHOOLING WITH PUBLIC HEALTH PROGRAMS

Estimates of the health reduced-form equations with interactive terms between maternal education and public health programs are presented in Table 4. These interactive terms show joint statistical significance at the 5% level for all age groups with the exception of the 3-6 year olds.

5.2.1 Community Cleanliness

The absence of visible excreta in the community is taken as a measure of the state of cleanliness in the environment. Full sample estimates show that maternal education is a substitute for community cleanliness as seen from the negative sign of their interactive term. Children with less educated mothers derive greater health gains from an improvement in the cleanliness of the environment. This is consistent with expectations, since better educated mothers have more information and skills which put them in a better position to protect their children against an unhealthy environment. This behavioral phenomenon is made even more apparent by looking at gains across age groups. Figure 1 graphically presents this interaction across age groups.[16]

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[16] The equation used for Figure 1 is

$$Y = ((a + (b \times MED))/HTAGE) \times 100$$

where Y = % change in height-for-age score
a = coefficient of uninteracted public health program variable from Table 4
b = coefficient of maternal education-public health program interaction from Table 4

The substitutability of maternal education for community cleanliness is preserved across all age groups with the exception of the 7-10 year olds (which is not individually statistically significant). There is a more pronounced substitutability for the ygest age group as evidenced by its slope which is the steepest among all the groups. Only the youngest and oldest age groups show statistical significance. The 0-2 year old children exhibit the greatest benefit from an improvement in community cleanliness when mothers have little or no schooling - when there is a failure on the part of the mother to offset the environmental health risks. Children of uneducated mothers in the 0-2 year age group show a 5.2% gain compared to 2.6% for the 11-15 year olds - a difference of a 100%.[17]

MED = mother's years of schooling

[17] The importance of taking interactions into account is illustrated by comparing Tables 3 and 4. In Table 3, it appears that community cleanliness does not affect the health of children in the 0-2 year age group since the coefficient is not statistically significant. However, from Table 4 and Figure 1, one observes that community cleanliness is important for these children after controlling for its interaction with maternal education. Hence, without taking this interaction into account, one could be led to the erroneous conclusion that community cleanliness has no effect on the very young.

5.2.2 Water Connections

The most common source of water for households in the community is taken as an indicator of the predominant type of water connections in the community. Water connections functionally serve to subsidize health inputs (water, in this case) and/or lead to an improvement in the healthiness of the environment. As such, no a priori prediction of the sign of the interactive term can be made on the basis of

The results for the full sample show that mother's education and community water connections are substitutes. Children of less educated mothers benefit more from the availability of a safe water source. The interactive term has a negative coefficient but is marginal in statistical significance (11%). This pattern of substitutability is repeated in all the age groups although only the 7-10 year olds show any statistical significance. Table 1 would suggest that in view of this substitutability, it is very likely that water connections primarily function to make the environment healthier (3rd column).

5.2.3 Community Toilet Connections

The predominant type of toilet used in the community indicates the available waste disposal infrastructure.[18]

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[18] This is justifiable because of the engineering

Just like water connections, toilet connections can serve as a subsidy to health inputs while simultaneously leading to an improvement in the healthiness of the environment. Hence, no a priori predictions can be made on the sign of the interaction on the basis of Table 1.

Mother's education is a complement to the provision of waste disposal infrastructure in the community. Its interactive term with the predominant type of toilet used in the community is positive and statistically significant (full sample). This means that children of more educated mothers derive greater health benefits from the availability of toilets. More educated mothers are in a better position to appreciate the value of these services owing to their better health knowledge and use them to their benefit. This pattern is preserved for all the age groups except for the youngest children. However, only the 7-10 year olds show statistical significance.[19]

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requirements that go with the use of certain types of toilets. For example, the predominant use of flush toilets in a community would suggest the availability of substantial complementary infrastructure such as sewage, septic tanks and water connections.

[19] The negative sign of the coefficients of the uninteracted variable for toilet may at first seem a puzzling result. Multiplying the interactive coefficients by the mean of maternal education and adding these to the coefficients of the uninteracted variable, we get the net value of the coefficient of TYPE OF TOILET as follows:

	(10E-3)
full sample:	-0.43
11-15 :	7.83
7-10 :	7.12
3-6 :	-6.50

Table 1 and the complementarity between maternal education and toilet connections suggest that this public health program functions primarily as a subsidy to health inputs (2nd column).[20]

5.2.4 Access to Health Care Facilities

The establishment of health care facilities can serve as a source of information and/or as a subsidy to health inputs (by lowering time and monetary costs) (columns 1 and 2 of Table 1). Hence, no a priori predictions can be made on the sign of the interactive term on the basis of Table 1.

Access to health care has a negative interaction with maternal education and is statistically significant for the full sample. This pattern of complementarity[21] is preserved

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0-2 : 3.93

The impact is greatest on the older children. This is consistent with results from Table 3 (without interactive terms). It is only for the full sample and 3-6 year olds that one gets the perverse negative signs.

[20] One can carry the test a step further. Maternal education can only serve as a substitute for community cleanliness and a complement to public health "subsidies" if this education leads to better sanitary conditions within the household. This can be tested by estimating the household demand for water and sanitation inputs with maternal education as a regressor. It should be a significant positive determinant in these equations. These equations are estimated in Barrera (1987) and results show that maternal schooling is indeed a positive and statistically significant determinant.

[21] Since access to health care is measured in terms of travel time, complementarity (substitutability) is indicated by a negative (positive) sign for its

for all age groups although it is only statistically significant for the oldest and the youngest age groups.[22]

5.3 IDENTIFYING THE NATURE OF MATERNAL EDUCATION'S ROLE

From the pattern of maternal education-public health program interactions, one can infer the most likely channels through which maternal education affects child health.[23] The absence of excreta around the community unambiguously leads to an improvement in the healthiness of the environment. This leads us to expect the elements in the last column of Table 1 to define the pattern of interaction between maternal education and this variable. Our finding of substitutability (less educated mothers benefit more),

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interactive term with the maternal schooling variable.

[22] The positive sign of the coefficients of the uninteracted variable for access to health care is contrary to expectations. However, multiplying the interactive term with the average of maternal education and adding this to the uninteracted variable of TRAVEL TIME TO LEAST-COST CHILD OUTPATIENT FACILITY gives us the following net impact:

	(10E-5)
full sample:	-0.56
11-15 :	-6.98
7-10 :	-6.06
3-6 :	5.11
0-2 :	8.05

Observe that all these show the correct negative sign with the exception of the preschoolers.

[23] The pattern of interactions of maternal education with water, sanitation and health care facilities cannot be predicted on the basis of Table 1. These programs cannot be exclusively categorized into one of the three main functional divisions. Community water and waste disposal

allows us to eliminate the role of maternal education in increasing the value of time (4th row) as a predominant channel, since in this latter case, it is the more-educated mothers who should benefit more.[24] One can therefore narrow down the most probable predominant roles to the first three rows. This range of roles can be narrowed further. If the operative role is due to an increase in family income (3rd row), then one should expect a significant interaction between income and public health programs, and observe family income to be a substitute for the healthiness of the environment and a complement to subsidized inputs. To test this conjecture, the health reduced-form equations are estimated with interactive terms between the public health program variables and income.[25] Only one of the 20 interactive erms exhibits statistical significance. A test

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connections can be treated both as leading to an improvement in the cleanliness of the environment and as subsidies to health inputs (columns 2 & 3). They could be considered as subsidies because substantial minimum investments for even the crudest systems considered safe are usually beyond the resources of an individual household. As such, the availability of these basic connections at the community level substantially reduces the cost of such inputs to the household. The establishment of health care facilities serves the functions of both subsidizing health care (by lowering the time and monetary costs) and providing health information (columns 1 & 2). As such, matching these to a single column in Table 1 is not possible. The only exception is the absence of excreta around the community.

[24] The role of maternal education in changing preferences (5th row) is disregarded as its effects are completely unknown.

[25] Results are not presented here but are available from the author upon request.

of the joint significance of the interactive terms show they are not statistically significant at the 5% level in any of the equations. Furthermore, the pattern of interactions is not consistent with our expectations from Table 1. The sign of the interaction of income with community cleanliness, toilet connections and access to health care indicates substitutability. The sign of the interactive term for source of water indicates complementarity. The substitutability of income with the absence of excreta around the community is consistent with Table 1 (element of last column and 3rd row). However, the interactions with toilet connections and water source are not consistent with expectations of complementarity and substitutability respectively.[26] Taken together, the pattern of interactions between income and public health pograms, statistically insignificant and different from predictions based on Table 1, suggests that one can eliminate the increase in family income as the predominant channel through which maternal education affects child health, at least for this sample. Furthermore, one can claim that maternal education affects child health by raising family income only if it can be

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[26] The interactions of these public health programs with maternal education suggest that TOILET CONNECTIONS function primarily as a subsidization of health inputs (2nd column) while WATER SOURCE functions primarily to improve the healthiness of the environment (3rd column). Hence, interacting these public health variables with household income should lead us to expect complementarity to TOILET CONNECTIONS (element of 2nd column, 3rd row of Table 1) and substitutability for WATER SOURCE (element of 3rd row and 3rd column of Table 1).

established that (1) maternal education does indeed increase family income, and (2) income positively affects child health. From Table 3, we see that income is not a statisticlly significant determinant of child height-for-age either for the full or stratified samples. From this we can infer that the positive impact of maternal education on child health in this sample does not come via an increase in family income. This reduces the most likely channels to that of augmenting the productivity of inputs (efficiency effect [row 1, Table 1] and that of reducing the costs of information (allocative effect) [row 2, Table 1].[27] This is similar to findings of allocative and efficiency effects in studies of farmer education and farm production (Jamison & Lau, 1982; Schultz, 1975).

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[27]The next question that comes to mind then is which of these two effects is predominant? Rosenzweig & Schultz (1981) propose a test to check whether there is an operative efficiency effect in child health production. This is accomplished by estimating the health production function and observing whether maternal education is statistically significant. An efficiency effect is said to be operative if the coefficient is statistically significant. A possible allocative effect may be present, but this cannot be conclusively verified with this test. This test is implemented in Barrera (1987). Health production functions both for the full and age stratified samples are estimated with food, breastfeeding and sanitation inputs using 2SLS. Empirical results confirm the presence of an efficiency effect. Furthermore, the results confirm the greater sensitivity of the health of the youngest age groups to maternal schooling.

6. SUMMARY AND POLICY IMPLICATIONS

6.1 SUMMARY

Maternal education positively affects child nutritional outcomes. Children of more educated mothers have better height-for-age scores. Furthermore, as predicted by the model, there is a difference in the impact of maternal schooling across age groups, with preschoolers showing the greatest sensitivity, especially children in the weaning period (below 2 years of age). This is a persistent finding throughout the study as seen (1) in the relatively larger coefficients of maternal education for the youngest children in the reduce-form equations,[28] and (2) in the more pronounced substitutability of maternal education with a cleaner environment and access to health care facilities for the 0-2 year age group compared to older children.

Children of less educated mothers derive greater health benefits from a cleaner environment and water connections, compared to children of more educated mothers. On the other hand, access to health care facilities and toilet connections benefit children of educated mothers more than the children of mothers with less schooling. These interactions with public health programs suggest that more educated mothers have better health knowledge which enables

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[28] and in the production functions as well. See Barrera (1987).

her to control her immediate environment and better appreciate the value of health inputs.

This pattern of interactions between maternal education and public health programs allows us to infer the most likely channels through which maternal education affects child health performance: (1) by affecting the productivity of health inputs (efficiency effect) and (2) by lowering the cost of information (allocative effect).

6.2 POLICY IMPLICATIONS

Very young children are commonly accepted to be the most vulnerable group in terms of nutritional stress, morbidity and mortality. Concern for their welfare has led to programs of direct assistance to this group. These empirical findings suggest that an improvement in the human capital of the mother is one possible avenue of assistance. In particular, maternal schooling is found to be associated with better child health. Maternal schooling, however, is only one way of enhancin human capital. Programs which directly provide health information and training to the mother may also lead to an improvement in her skills and ability to efficiently use and effectively allocate health inputs for better child health, without going through a roundabout general education program. Primary health care programs should focus not only on direct assistance to the

child but should also seek ways of improving the mother's ability at child rearing. This is particularly true in the case of very young children whose health shows relatively greater sensitivity to the mother's human capital.

Another policy implication is the distributional consequences of primary health care programs. If maternal education affects child health principally through efficiency and allocative effects, as these results suggest, and if less educated mothers generally come from poorer families, then, equity considerations give preference to programs which either lead to an improvement in the healthiness oe environment and/or disseminate health information. These types of programs lead to relatively greater benefits for the poor, among whom children are at the greatest health risk. Programs which primarily subsidize health inputs may not be optimal as they can have a regressive distribution of benefits.

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TABLE 1

Matrix of Maternal Education-Public Health Program Interaction

WHO BENEFITS MORE ?

Roles of Education	Nature of Public Health Program: Provision of information	Subsidization of health inputs	Improvement in healthiness of environment
1. increase in productivity of inputs	unknown	unknown	less educated
2. lower costs of information	less educated	more educated	less educated
3. increase family income	unknown	more educated	less educated
4. increase in value of time	unknown	less educated	more educated
5. change in preference	unknown	unknown	unknown

source: Rosenzweig & Schultz (1982) and Schultz (1984)
Explanation of matrix entries:

(a). Less educated mothers have less access to information and limited skills to use such, thereby impairing their ability to protect their children from environmental health hazards. An improvement in the healthiness of the environment would compensate for this inability (row 1, column 3; row 2 column 3)

(b). If health programs provide subsidized health inputs, more educated mothers would benefit more. These mothers understand more precisely the value of these subsidized health inputs and therefore utilize and benefit more from these services (row 2, column 3),z ceteris paribus. Furthermore, if maternal education leads to higher family incomes, these educated mothers purchase more of these services (row 3, column 2)

(c). Maintaining cleanliness requires time input on the part of the mother. Hence, it education increases the value of time (row 4) and there is an improvement in the healthiness

of the environment (column 3), the value of time saved is greater for the more educated mothers, ceteris paribus.

(d). Maintaining cleanliness requires the use of certain assets and/or purchased goods (cleansers, etc.). Hence, if maternal education increases family income (row 3) and there is an improvement in the healthiness of the environment (column 3), the gains would be relaely greater for the less educated who are less able to maintain cleanliness because of the lack of complementary assets/income, ceteris paribus.

(e). The use of health inputs require time inputs on the part of the mother. If maternal education increases the value of time (row 4), the cost of using health services would be relatively greater for more educated mothers. Hence, if time were the only cost to using health services, less educated mothers would be utilizing more of it, thereby gaining more from the subsidy (column 2).

TABLE 2

LIST OF VARIABLES AND DEFINITIONS

Variable	MEAN	STD. DEV.
Endogenous Variables		
STANDARDIZED HEIGHT-FOR-AGE	0.894	0.064
Exogenous Variables		
CHILD AGE (months)	86.510	49.740
COMMUNITY WAGE RATE FOR WOMEN (pesos)	1.350	0.914
FAMILY INCOME (excl. MOTHER'S EARNINGS)	9922.000	0.208E+5
LOCATION DUMMY (village=1; town=0)	0.860	0.347
MATERNAL EDUCATION (years)	5.990	3.347
MOTHER'S AGE (years)	37.780	9.699
MOTHER'S HEIGHT (centimeter)	126.700	72.920
PRICE OF MILK (pesos)	3.619	0.208
PRICE OF RICE (pesos)	2.065	0.092
PRICE OF COOKING OIL (pesos)	1.548	0.470
PRICE OF KEROSENE (pesos)	0.575	0.109
SEX (male=1;female=0)	0.515	0.500
SUFFICIENCY OF WATER FOR HH USES IN COMMUNITY (sufficient=1)	0.956	0.203
PREVALENT HH SOURCE OF WATER IN COMMUNITY (piped=1;zero otherwise)	0.757	0.428
PREVALENT TYPE OF TOILET IN COMMUNITY (water-sealed=1)	0.556	0.497
ABSENCE OF EXCRETA IN ENVIRONS OF COMMUNITY (none or little = 1)	0.820	0.383
TRAVEL TIME TO LEAST-COST HEALTH FACILITY WITH CHILD OUTPATIENT SERVICES (minutes)	33.860	46.910

TABLE 3

HEALTH REDUCED-FORM EQUATION FOR HEIGHT-FOR-AGE

	AGE GROUPS				
	(1) FULL SAMPLE	(2) 11-15	(3) 7-10	(4) 3-6	(5) 0-2
CONSTANT	0.448	0.587	0.387	0.461	0.586
	(10.48)	(3.83)	(2.91)	(5.29)	(4.67
CHILD AGE (months)	-0.344E-03	-0.319E-02	0.901E-03	-0.110E-03	-0.808E-
	(-4.33)	(-1.74)	(0.42)	(-0.09)	(-4.29
CHILD AGE SQUARED (months)	0.488E-06	0.104E-04	-0.404E-05	0.581E-06	0.189E-
	(1.13)	(1.71)	(-0.37)	(0.05)	(2.65
SEX (male=1)	-0.331E-02	-0.100E-01	-0.193E-02	-0.280E-03	-0.564E-03
	(-1.66)	(-3.18)	(-0.50)	(-0.07)	(-0.10
MOTHER'S HEIGHT	0.288E-02	0.354E-02	0.264E-02	0.244E-02	0.281E-
	(15.40)	(11.94)	(7.36)	(6.65)	(5.15
MOTHER'S SCHOOLING	0.139E-02	0.903E-03	0.123E-02	0.168E-02	0.213E-
	(3.87)	(1.56)	(1.81)	(2.31)	(2.12
MOTHER'S AGE	0.120E-02	0.122E-02	0.879E-03	0.154E-02	0.787E-
	(8.20)	(5.14)	(3.10)	(5.34)	(1.79
INCOME (excl mother's)	0.540E-07	0.119E-06	0.324E-07	-0.385E-07	0.176E-
	(1.09)	(1.55)	(0.33)	(-0.39)	(0.12
PRICE OF DRUGS	-0.156E-04	0.396E-04	-0.657E-04	-0.124E-04	0.148E-
	(-0.59)	(1.00)	(-1.26)	(-0.25)	(0.16
PRICE OF RICE	-0.141E-02	-0.822E-02	0.140E-01	0.100E-02	-0.138E-
	(-0.11)	(-0.41)	(0.60)	(0.04)	(-0.39
PRICE OF COOKING OIL	-0.281E-02	-0.339E-02	-0.103E-01	0.172E-02	0.867E-
	(-1.15)	(-0.88)	(-2.25)	(0.34)	(1.23
PRICE OF KEROSENE	0.101E-01	-0.120E-01	0.194E-01	0.997E-02	0.190E-
	(0.98)	(-0.67)	(0.99)	(0.50)	(0.68
PRICE OF MILK	-0.426E-02	-0.797E-02	-0.436E-05	-0.836E-03	-0.162E-
	(-0.84)	(-0.94)	(0.00)	(-0.08)	(-1.19
LOCATION DUMMY (VILLAGE=1;TOWN=0)	-0.615E-02	-0.504E-02	-0.445E-02	-0.505E-02	-0.177E-
	(-1.77)	(-1.00)	(-0.68)	(-0.68)	(-1.61
COMMUNITY WAGE RATE FOR WOMEN	-0.115E-03	-0.115E-02	0.131E-02	0.139E-02	-0.519E-
	(-0.09)	(-0.57)	(0.53)	(0.55)	(-1.40)

Table 3 (continuation)

	(1) FULL SAMPLE	(2) AGE GROUPS 11-15	(3) 7-10	(4) 3-6	(5) 0-2
TRAVEL TIME TO LEAST-COST CHILD OUTPATIENT FACILITY X LOCATION DUMMY	0.272E-04 (1.12)	0.182E-04 (0.47)	-0.455E-04 (-0.98)	0.694E-04 (1.47)	0.148E- (2.01
PREDOMINANT COMMUNITY TYPE OF TOILET (water-sealed=1)	-0.179E-02 (-0.76)	0.660E-02 (1.72)	0.281E-02 (0.61)	-0.768E-02 (-1.68)	-0.155E- (-2.38
ABSENCE OF EXCRETA (community)	0.688E-02 (2.47)	0.746E-02 (1.70)	0.237E-02 (0.43)	0.116E-01 (2.0)	0.586E- (0.77)
PREDOMINANT COMMUNITY WATER SOURCE (piped=1)	0.277E-02 (1.04)	0.200E-02 (0.45)	0.608E-03 (0.11)	-0.118E-02 (-0.23)	0.142E- (1.92
no. of observations	3821	1095	1098	1098	530
R-squared	0.098	0.162	0.073	0.075	0.191
F-statistic	23.016	11.597	4.701	4.893	6.712
Sum of sq residuals	14.313	2.910	4.299	4.468	2.107

TABLE 4

INTERACTION OF MATERNAL SCHOOLING WITH PUBLIC HEALTH PROGRAMS

		AGE GROUPS			
	FULL SAMPLE	11-15	7-10	3-6	0-2
CONSTANT	0.419 (9.50)	0.533 (3.43)	0.373 (2.76)	0.428 (4.75)	0.523 (4.05
CHILD AGE (months)	-0.329E-03 (-4.14)	-0.304E-02 (-1.67)	0.102E-02 (0.48)	-0.218E-03 (-0.19)	-0.815E- (-4.34
CHILD AGE SQUARED (months)	0.429E-06 (0.99)	0.100E-04 (1.64)	-0.474E-05 (-0.43)	0.185E-05 (0.16)	0.193E- (2.72
SEX (male=1)	-0.324E-02 (-1.63)	-0.938E-02 (-2.96)	-0.202E-02 (-0.52)	0.121E-03 (-0.03)	-0.950E-03 (-0.16
MOTHER'S HEIGHT	0.286E-02 (15.25)	0.351E-02 (11.80)	0.265E-02 (7.41)	0.241E-02 (6.56)	0.269E- (4.92
MOTHER'S SCHOOLING	0.736E-02 (3.74)	0.102E-01 (2.48)	0.363E-02 (0.83)	0.830E-02 (1.95)	0.159E- (2.81
MOTHER'S AGE	0.170E-02 (6.25)	0.192E-02 (3.85)	0.124E-02 (2.20)	0.246E-02 (3.76)	0.158E- (1.51
INCOME (excl mother's)	0.631E-07 (1.27)	0.124E-06 (1.62)	0.651E-07 (0.67)	-0.232E-07 (-0.23)	0.428E- (0.03
PRICE OF DRUGS	-0.200E-04 (-0.76)	0.333E-04 (0.84)	-0.751E-04 (-1.44)	-0.119E-04 (-0.24)	0.117E- (0.13
PRICE OF RICE	-0.356E-03 (-0.02)	-0.707E-02 (-0.36)	0.192E-01 (0.82)	0.297E-02 (0.12)	-0.168E- (-0.48
PRICE OF COOKING OIL	-0.315E-02 (-1.29)	-0.360E-02 (-0.93)	-0.107E-01 (-2.32)	0.182E-02 (0.36)	0.705E- (0.99
PRICE OF KEROSENE	0.106E-01 (1.03)	-0.138E-01 (-0.77)	0.188E-01 (0.97)	0.848E-02 (0.42)	0.186E- (0.67
PRICE OF MILK	-0.480E-02 (-0.94)	-0.774E-02 (-0.92)	-0.362E-02 (-0.36)	-0.195E-02 (-0.19)	-0.143E- (-1.05
LOCATION DUMMY (VILLAGE=1;TOWN=0)	-0.519E-02 (-1.48)	-0.295E-02 (-0.57)	-0.296E-02 (-0.45)	-0.302E-02 (-0.40)	-0.172E- (-1.55
COMMUNITY WAGE RATE FOR WOMEN	-0.263E-03 (-0.20)	-0.127E-02 (-0.62)	0.515E-03 (0.20)	0.130E-02 (0.51)	-0.430E- (-1.16

Table 4 (continuation)

	FULL SAMPLE	AGE GROUPS 11-15	7-10	3-6	0-2
TRAVEL TIME TO LEAST-COST CHILD OUTPATIENT FACILITY X LOCATION DUMMY	0.104E-03 (2.22)	0.128E-03 (1.90)	-0.323E-04 (-0.38)	0.138E-03 (1.25)	0.461E- (2.57
PREDOMINANT COMMUNITY TYPE OF TOILET (water-sealed=1)	-0.124E-01 (-2.40)	0.779E-03 (0.09)	-0.274E-01 (-2.79)	-0.213E-01 (-2.02)	-0.678E- (-0.46
ABSENCE OF EXCRETA (community)	0.192E-01 (3.22)	0.230E-01 (2.71)	-0.429E-02 (-0.36)	0.229E-01 (1.73)	0.465E- (2.58
PREDOMINANT COMMUNITY WATER SOURCE (piped=1)	0.104E-01 (1.77)	0.217E-02 (0.23)	0.230E-01 (2.06)	0.960E-03 (0.07)	0.280E-0 (1.66
INTERACTION WITH MATERNAL SCHOOLING:					
PREDOMINANT COMMUNITY TYPE OF TOILET (water-sealed=1)	0.190E-02 (2.27)	0.112E-02 (0.74)	0.548E-02 (3.48)	0.235E-02 (1.41)	-0.170E (-0.7
ABSENCE OF EXCRETA (community)	-0.205E-02 (-2.28)	-0.277E-02 (-2.05)	0.111E-02 (0.62)	-0.186E-02 (-0.95)	-0.619E (-2.4
TRAVEL TIME TO LEAST-COST CHILD OUTPATIENT FACILITY X LOCATION DUMMY	-0.174E-04 (-2.05)	-0.314E-04 (-2.15)	-0.450E-05 (-0.30)	-0.138E-04 (-0.75)	-0.604E (-1.9
PREDOMINANT COMMUNITY WATER SOURCE (piped=1)	-0.158E-02 (-1.57)	-0.369E-03 (-0.20)	-0.442E-02 (-2.26)	-0.455E-03 (-0.22)	-0.236E (-0.8
no. of observations	3821	1095	1098	1098	530
R-squared	0.104	0.173	0.087	0.081	0.210
F-statistic	19.070	9.766	4.445	4.140	5.850
Sum of sq residuals	14.229	2.872	4.233	4.439	2.058

Figure 1
INTERACTION OF MATERNAL EDUCATION WITH AN EXCRETA-FREE ENVIRONMENT